



Activity 6: What Next?

Purpose

To recommend ways to incorporate the topic of Mars into a classroom and curriculum.

Overview

Space exploration provides many important connections to the classroom, yet how does one tap into what a mission has to offer? This activity presents a variety of approaches for bringing the topic of Mars into the classroom. These range from a modest level of commitment such as maintaining a Mars bulletin board to a high level of commitment such as having students conduct research using recent images and data from Mars.

Different Ways of Integrating a Space Mission into Your Curriculum

Science results based on past missions to Mars are constantly emerging, and plans for new missions are underway. How can a teacher keep the curriculum-connection current? How does a busy teacher navigate all the available resources to find the ones most suited to his or her lessons? What kinds of activities are effective in helping students understand the many aspects of a mission? How does one bring a mission to life in the classroom?



Getting Started has introduced you and your students to Mars, the solar system, and space exploration. It has also provided an opportunity for your students to generate questions, experience inquiry-based learning, refine their analysis skills, conduct experiments, and make Mars/Earth comparisons. Also, they have seen that the very latest data and images from Mars – the same information that scientists are using in their research – are available on the Web. You could stop here, having provided an excellent introduction to Mars and space exploration. However, how can you build on this base and keep the Mars connection to your curriculum open? You might:

1. use one of the other education modules in JPL's Mars Exploration Program.
2. conduct investigations based on questions students have generated, using the modeling, experimentation and analysis skills developed in this module.
3. find a Mars connection to other topics in your curriculum.

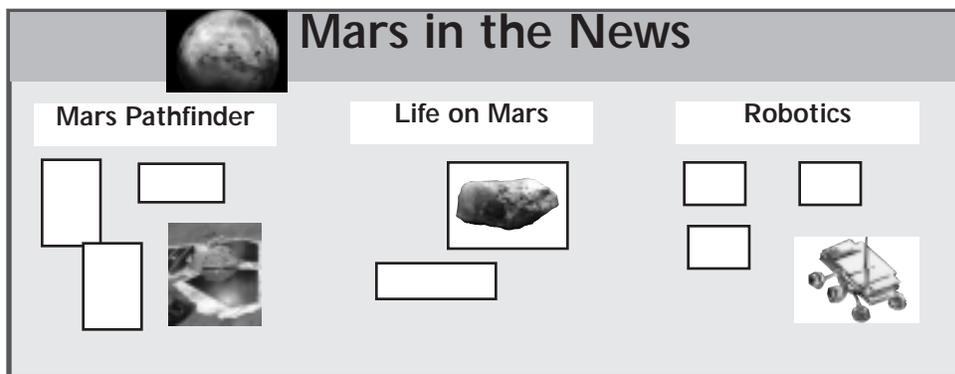


There are many ways to tap into what a mission has to offer. This activity uses the Mars Pathfinder mission to show how you can find out information about a mission and find connections to what you teach. The techniques described here can be used with any mission. Let's look at these approaches to see how one might link the Mars Pathfinder mission to the classroom.

Use a Mars Mission as a Current Event

Typically, the information sources for current events are printed materials, television, radio, and the Web. Occasionally, teachers are able to schedule presentations by people familiar with or involved in an event, and sometimes students can conduct interviews with such people. Formats to share information include bulletin boards, oral reports, student reports, and current event notebooks. Each of these methods involves students in different ways and at different levels of intensity. Below are several ways the Pathfinder mission could be used in a current events context:

- The mission's data and images will be used for decades by scientists researching Mars. Check newspapers and magazines for articles on the science resulting from their work.
- There is an enormous amount of information about the mission the *Pathfinder* Web site, everything from the people involved to the current weather conditions on Mars to the latest results based on Pathfinder data and images to the latest images themselves. The Web site will also link you to other sites related to the mission.
- Shows about Mars air on television or radio, and NASA's cable and satellite channel, NASA Select, has frequent updates about its various missions. Students can take notes on a show and prepare a report based on the information presented.
- A bulletin board is a convenient way to organize and prominently display information. You might organize a bulletin board by topics such as:
 - Mars Pathfinder
 - Life on Mars
 - Robotics
 - Mars Global Surveyor
 - Water on Mars
 - Questions About Mars
 - Other Space Missions
 - Human missions to Mars
 - Future missions to Mars



Sample Bulletin Board Layout

Obtain Images and Data Sets To Analyze and Interpret.

One way to develop students' analytical skills is by having them interpret images or data sets, preferably ones relating to something students are studying or in which they have an interest. For example, students studying weather or geology can make interesting Mars-Earth comparisons by looking at Pathfinder's Martian weather reports and geology data. Having students examine and contemplate images from another planet can lead to exciting questions that can serve as the basis for student-based investigations. Each module in the Mars Exploration Program guides teachers in how to use data and images effectively to develop students' analysis and interpretation skills. In addition, the module activities encourage students to generate questions.



Pathfinder's data and images are available at its Web site. The best way to determine the kinds of data and images available from a mission is to visit its homepage and find out what instruments are on the spacecraft. Each instrument has a specialized purpose. Match topics in your curriculum to the images or data returned by one or more of the instruments. Be creative. For example:

- compare the dust on Earth and Mars. *Pathfinder* has magnets attached at different heights. Images of these magnets will be used to determine the amounts of magnetic minerals in the Martian dust.
- compare seasonal variation on Earth and Mars. *Pathfinder* has instruments to measure the temperature, pressure, and wind speed at various heights above the surface. How do Martian conditions compare to those on Earth? Do temperatures at various heights vary in the same way on both planets?
- use the images of the landing site to create a model of the landing site or have students construct a birds-eye view based on the views from the lander cameras.

Use Student Questions as the Basis for Experiments and Models

As students analyze images or data sets, questions will emerge. Questions such as: What would cause that feature? How might this form? or Why do I usually see these two features together? are springboards for inquiry. Students need to devise a hypothesis, design a model or experiment, collect and analyze data or images, and draw a conclusion. Often, one question leads to another. You can have students take a question they have recorded in their Mars Journals and detail how they would investigate it. Such a plan could be the basis for an investigation or project.



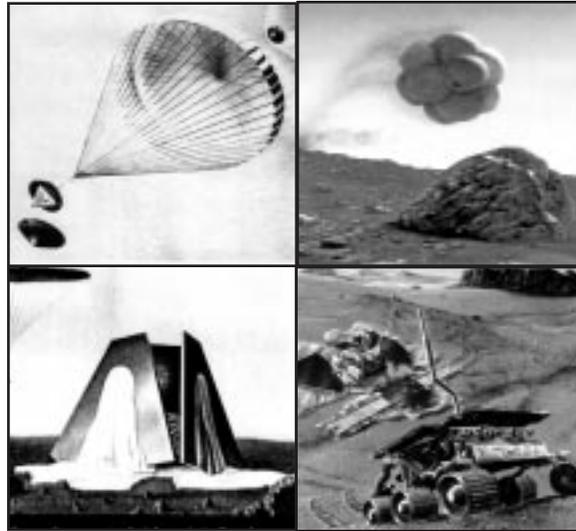
Learn About the Scientists and Engineers Involved in a Mission

For many students, knowing about the people involved in a mission brings it to life. Most mission-related Web pages have pictures and short descriptions of the key people working on a mission. Teachers can profile various individuals as role models or develop career awareness. Occasionally, scientists and engineers host a chat or enable students to send them e-mail messages. For example, the *Pathfinder* team hosted a chat every night for the first few months of the mission. Students can do reports, collages, or posters to bring out the human dimension of a mission.



Donna Shirley, Manager of NASA's Mars Exploration Program

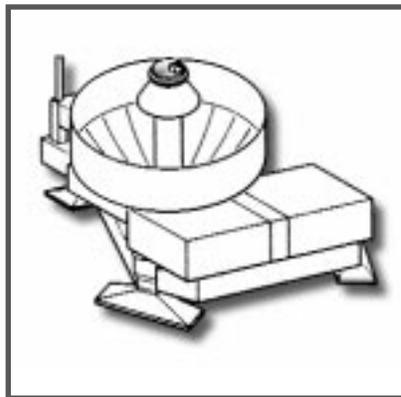
Explore Engineering/Design Issues With Mechanisms, Simulations, and Models



The *Pathfinder* mission offers many examples of how engineers met a variety of challenges:

- landing the spacecraft safely by encasing it in 24 balloons
- constructing a controllable rover
- designing a reliable ramp system so *Sojourner* could drive off the solar panel onto the Martian surface
- building a suspension system that lets *Sojourner* navigate rocky terrain safely
- making instruments to carry out specific tasks
- designing reliable communication systems

Students can make scale models such as NASA's spacecraft paper model kits or



MGS's Laser Altimeter

invent mechanisms that carry out specific tasks. For example, students can model how an altimeter works by arranging objects in the bottom of a deli container, covering the opening with paper, and pushing pencils through the paper. By measuring how far down the pencil goes at each position sampled, students can map the arrangement of the objects. An altimeter works on the same principle using a laser beam. The *Pathfinder* Web page has information on each instrument and on how the design team dealt with the various challenges.

Students can become immersed in a topic through simulations such as the Planetary Society's "Red Rover, Red Rover – Rover Simulations" and the Challenger Center's "Marsville" and "Mars City Alpha Kits" which present many engineering challenges. Teachers like simulations because they ask students to integrate many disciplines.

Consider How Conditions on Mars Could Affect Processes that Students Have Studied

Earth is twice the size of Mars, has two and a half times the force gravity, has an atmosphere 100 times denser, and has 150 times the atmospheric pressure at the surface. In addition, Mars has no surface water and the temperature averages around -80°C (-62°F). Earth, life and physical science students can have many fruitful discussions about how the processes they have studied would change under these conditions. As students learn about various topics, they can extend their understanding to Mars. By understanding how a process might function in the Martian environment, students can gain additional insight into the topic they have studied. What consequences do the different conditions found on Mars impose on processes such as the water cycle, weather, or life? These realizations lead to a deeper understanding of the planet.

- What kinds of adaptations might be required to live under such conditions? Students might look at the kinds of adaptations organisms on Earth have made to different environments and speculate about what adaptation would make life on Mars possible.
- Can liquid water exist on Mars? Is there a water cycle? Students could look at how Earth's temperatures and pressures enable water to exist in all three states. By graphing the temperature as water goes from ice to steam, students learn about heat energy, phase change, and atmospheric pressure. After putting these concepts in the context of Earth's water cycle, they are able to discuss the water cycle on Mars, as well as Martian storm patterns, and seasonal cycles.
- Why is our blood based on table salt? Would another substance work as well? Biology or chemistry students could create saturated solutions of different chemicals at a variety of temperatures. By plotting their data, students understand that when the temperature of a saturated solution falls to a certain point, some solute will precipitate. They try the same experiment with table salt. Students are astonished that water holds the same amount of table salt over a tremendous range of temperatures. With this information, students can understand the benefit our blood derives from being based on table salt and can speculate on whether life as we know it could exist on Mars.

